JOURNAL
OF THE
WASHINGTON ACADEMY OF SCIENCES

VOL. 18 NOVEMBER 19, 1928 No. 19

PHYSICS.—*A new equation for the determination of surface tension from the form of a sessile drop or bubble.*[1] N. ERNEST DORSEY, National Research Council.

Although the value of the surface tension can not be deduced from measurements of the dimensions of a sessile drop or bubble with as high an accuracy as it can be obtained by other methods, yet the method of sessile drops and bubbles, especially with the aid of photography, is particularly well adapted to the investigation of any secular change that may occur in the surface, such as the progressive decrease in the effective tension when the liquid contains certain colloidal substances.

The measurements can be made upon a suitable photograph of the profile of the surface. Photographs can be taken at such intervals as may be desired, and the time at which each is taken can be accurately determined. While doing this, the surface under study is not disturbed in any way. By none of the methods commonly used can such a series of measurements upon an undisturbed surface be obtained. Furthermore, the measurements of the photographs can be made at one's leisure, and can be repeated as often as may be desired.

Heretofore, the only means available for computing the surface tension from the dimensions of a sessile drop or bubble have been formulae (1), (2), (3), and (4) and a table prepared by Heydweiller[2] from Siedentopf's graphical computations and the formulae (2), (3), and (4):

[1] Received October 6, 1928.

[2] A. HEYDWEILLER. Wied. Ann. **65**: 311-319. 1898.

$$A^2 = \frac{K_\theta^2}{4\cos^2\frac{\theta}{2}}\left[1 - \frac{8A^3\left(1-\sin^3\frac{\theta}{2}\right)}{3rK_\theta^2} + \frac{4A^2}{RK_\theta} - \cdots\right] \quad (1)^3$$

$$\left(\frac{r}{A}\right)^8 + 328\left(\frac{r}{R}\right)^2\left(\frac{r}{A}\right)^6 + \left[720 + 2520\left(\frac{r}{R}\right)^4\right]\left(\frac{r}{A}\right)^4$$

$$+\left[17280 + 2880\left\{\left(\frac{r}{R}\right)^2 + \left(\frac{r}{R}\right)^6\right\}\right]\left(\frac{r}{A}\right)^2 = 138240\left(\frac{R-r}{r}\right) \quad (2)^4$$

$$\sqrt{\frac{1+\frac{3A^2}{RK_{90}}}{2+\frac{K_{90}}{r}}} > \frac{A}{K_{90}} > \frac{1+\frac{2A^2}{RK_{90}}}{\sqrt{2+\frac{2K_{90}}{r}+\frac{8A^2}{rR}-\frac{4A^2}{r^2}}} \quad (3)^5$$

$$\frac{A}{R} = \frac{2\sqrt{2\pi}}{1+\sqrt{2}}\left(\sqrt{\frac{r}{A}+2-\sqrt{2}}\right)e^{\left(\sqrt{2}-2-\frac{r}{A}\right)} \quad (4)^6$$

In these formulae, $A^2 = T/g(d - d')$, T being the surface tension, g the acceleration of gravity, and $(d - d')$ the positive difference in the densities of the fluids separated by the surface; r is the radius of the maximum horizontal section of the drop or bubble, R is the radius of curvature of the vertex (B, Fig. 1) of the surface, and the quantities represented by the other symbols are as indicated in Fig. 1.

Heydweiller's table is based on the quantities r and K_{90}, covers the entire range of sizes, and is estimated to be of such accuracy as to give T with an error not exceeding 1 per cent in excess of that introduced by errors in the measurements. He seems to have prepared and checked the table with care, but it appears to have remained unused by others.

[3] W. F. MAGIE. Phil. Mag. (5)**26**: 162–183. 1888; Wied. Ann. **25**: 421–437. 1885; A. FERGUSON. Phil. Mag. (6)**25**: 507–520. 1913; J. E. VERSCHAFFELT. Proc. K. Akad. Amsterdam **21**: 836–849. 1919; Leiden Communications, Suppl. 42e. 1918; S. D. POISSON. *Nouvelle théorie de l'action capillaire.* 1831.

[4] TH. LOHNSTEIN. Wied. Ann. **54**: 713–723. 1895.

[5] TH. LOHNSTEIN. Wied. Ann. **53**: 1062–1073. 1894.

[6] S. D. POISSON. *Nouvelle théorie de l'action capillaire* (See Heydweiller, *l. c.*).

All the formulae involve the quantity R, and, excepting (2) and (4), the quantity K. Under suitable conditions, the value of R can be determined with fair accuracy from observations made upon the surface itself, but it can not be satisfactorily determined from photographs of the profile. The determination of K_{90} involves an exact determination of the position of the plane of maximum horizontal section; this can not be done satisfactorily. Equation (1) might be used with any value of θ, but in each case the difficulty of determining the position of the plane at which the surface has that inclination arises, except when θ corresponds to the line of contact of the surface with the solid against which the drop or bubble rests. In that case,

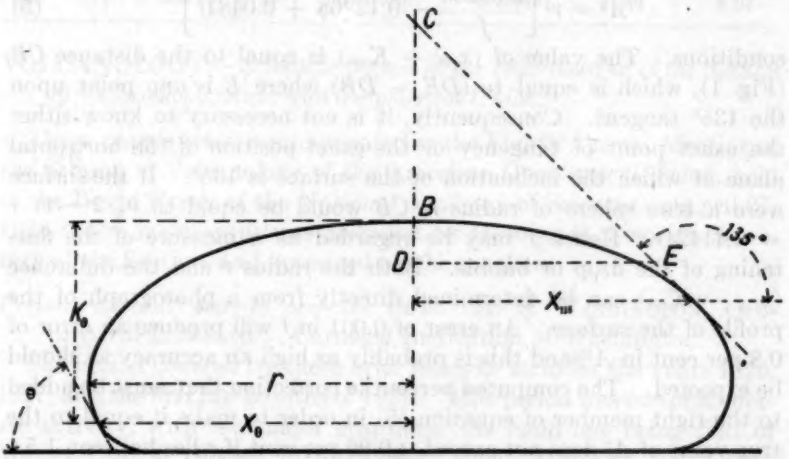

Figure 1

θ must be determined experimentally, and such a determination is beset with difficulties.

The table and all the formulae involve quantities that can not be determined satisfactorily from measurements of the profile of the surface. Furthermore, the formulae are awkward to use, and the order of approximation of the one (1) that is simplest and most frequently used is quite unsatisfactory except for large drops or bubbles. For example, if $r^2 = 10A^2$, which corresponds to a water drop about 1.7 cm. in diameter, the values of A^2 as computed from equation (1) with $\theta =$ 0°, 90°, and 135° will be too great by 3.7 per cent, 6.6 per cent, and 16.5 per cent, respectively.

Hence, in view of the special adaptation of this method to the study of secular changes in the surface, it seemed desirable to attempt to obtain from the tables of Bashforth and Adams[7] an empirical equation that contains only such linear quantities as can be readily determined from a photograph of the profile of the surface, and as require no exact knowledge of the position of the horizontal plane at which the surface has a specified inclination. This equation should have an accuracy well in excess of that set by the inherent errors in the measurement of the photograph.

Equation (5), in which $f = \frac{x_{135} - K_{135}}{r} - 0.41421$, fulfills thes

$$A^2 = r^2\left[\frac{0.05200}{f} - 0.12268 + 0.0481f\right] \qquad (5)$$

conditions. The value of $(x_{135} - K_{135})$ is equal to the distance CB (Fig. 1), which is equal to $(DE - DB)$ where E is *any* point upon the 135° tangent. Consequently, it is not necessary to know either the exact point of tangency or the exact position of the horizontal plane at which the inclination of the surface is 135°. If the surface were a true sphere of radius r, CB would be equal to $(\sqrt{2} - 1)\ r = 0.41421r$. Hence f may be regarded as a measure of the flattening of the drop or bubble. Both the radius r and the difference $(x_{135} - K_{135})$ can be determined directly from a photograph of the profile of the surface. An error of 0.001 in f will produce an error of 0.8 per cent in A^2, and this is probably as high an accuracy as should be expected. The computed percentile correction that must be added to the right member of equation (5) in order to make it equal to the true value of A^2 does not exceed ± 0.06 per cent if r lies between $1.5A$ and $3.2A$ (Table 1), and actually differs little from the errors of computation. Hence, equation (5) itself is of ample accuracy, and the computed data in Table 1, covering the entire range of the Bashforth and Adams' tables, indicate that this equation will be quite satisfactory for still larger drops. For such drops, the accuracy of the values derived by equation (5) can be checked, within the limit of accuracy with which K_{90} can be determined, by means of Heydweiller's table.

[7] BASHFORTH and ADAMS. *An attempt to test the theory of capillary action.* Cambridge Univ. Press, 1888.

TABLE 1.—CONSTANTS FOR SESSILE DROPS AND BUBBLES

$$A^2 = r^2\left[\frac{0.05200}{f} - 0.12268 + 0.0481f\right](1+\delta);\quad \frac{dA^2}{A^2} = -\omega\frac{df}{f}$$

r_w = value of r if $A^2 = 0.075$ cm.,[2] approximately the value for water.

$\left(\frac{R}{A}\right)^2$	$\frac{r}{A}$	r_w	δ	f	ω	$\frac{\omega}{f}$
0.125	0.3466	0.095 cm.	+1.34%	0.00624	1.015	163.
1.0	0.8853	0.242	+0.48	0.03739	1.094	29.2
3.0	1.3350	0.366	+0.10	0.07652	1.206	15.76
6.0	1.6645	0.456	0.00	0.10872	1.311	12.07
12.5	2.0388	0.558	−0.02	0.14595	1.453	9.96
25.	2.4074	0.660	−0.02	0.18147	1.598	8.81
50.	2.7841	0.763	−0.04	0.21543	1.789	8.30
100.	3.1646	0.868	+0.01	0.24685	1.991	8.07

VOLCANOLOGY.—*Scientific papers at the 1928 meeting of the Section of Volcanology, American Geophysical Union.*[1]

These papers were communicated at the Eighth Annual Meeting of the Section of Volcanology of the American Geophysical Union, held in the Board Room of the National Academy of Sciences on April 27, 1928. The manuscript was prepared by ROBERT B. SOSMAN, Secretary of the Section, and approved by the speakers.

Present volcanic activity over the earth. H. S. WASHINGTON, Geophysical Laboratory, Carnegie Institution of Washington.

The period covered by these brief remarks includes the years 1926, 1927, and the first few months of 1928. This period was one of moderate activity, with few major eruptions, the main one being that of Mauna Loa, in Hawaii, in April 1926, which, however, lasted only about three weeks. Since then it has been quiet. Subsequent to the very violent explosive eruption of Halemaumau in Kilauea (May, 1924) the crater of Halemaumau has been nearly quiescent, the lava having sunk out of sight some years ago. Lava appeared for two weeks in July, 1927, but there are no very striking signs of renewed activity. The 40 odd volcanoes of the Aleutian Islands would seem to have had a season of unusual activity during 1927, according to Dr. Jaggar, who visited them that year. Mageik, near the volcano of Katmai (Valley of Ten Thousand Smokes) was in eruption in October, 1927, when a large area was covered with ash. Throughout the Pacific the volcanoes generally have been quiet, except for an eruption

[1] Received September 28, 1928.

at the Tonga Islands (1927) and a new volcano at the Galapagos (1926). Lassen Peak was quiet during most of this period, but there was an unverified report of an eruption in May, 1927. An observatory was established at this volcano in 1926 to study the vocanic phenomena and earthquakes. In Japan there were two volcanoes in eruption on the island of Hokkaido during 1926 which did considerable damage. Izalco, in San Salvador, almost continuously active, had a specially violent eruption in November, 1926, when 56 people were killed by a flood of lava. Colima, in Mexico, was reported active in January, 1926, after 12 years of repose.

Vesuvius was in its usual state of minor activity, but had eruptions in the summer of 1926, when lava is said to have poured down the outer slope. This was much exaggerated in the newspapers. The reported activity of the Solfatara is somewhat doubtful (1926). The eruption of the Fouqué Volcano at Santorini, Greece, which began in August, 1925, came to an end in 1926, but it is reported to have resumed activity in May, 1927. The volcanoes of the Dutch East Indies appear to have been in their normal condition of activity, except that an apparently somewhat violent submarine eruption at Krakatoa took place in January, 1928. It is not known whether this is continuing or not. This is the volcano that had a first-magnitude explosive eruption in 1883.

There were no reports of eruptions in South America or in Iceland.

(*Abstract.*)

The year's volcanological publications. ARTHUR L. DAY, Geophysical Laboratory, Carnegie Institution of Washington.

The volcano reports of the leading periodical of volcanology, the *Zeitschrift für Vulkanologie*, are of two kinds: (1), student's studies of individual volcanoes; (2), reports from field observers. The latter were relatively few in 1927. A descent of Etna was described, but the conditions as regards gases and smoke must have been very different from those met with by the speaker in 1924.

The most conspicuous publication of the year was Karl Sapper's *Vulkankunde*. This is particularly strong on the historical side. It is the result of about ten years of work. Less attention is paid in the book to the psysico-chemical side than the speaker would have liked. Historically, the account is very complete from the Tertiary down. There is full discussion of the kind of phenomena seen at volcanoes: gases, lavas, and sequences of products. Silicate relations are hardly considered. In all, it is the best available book on volcanism.

Another conspicuous event is the establishment of regular reports from the Dutch East Indies in languages other than Dutch, in pursuance of a proposal made at the Japanese Pan-Pacific Congress.

The amount of information on hot earth zones in the United States is increasing. Since the publication of Allen and Day's monograph on the steam wells in California, additional borings have been made, and there have also been added one boring in the Imperial Valley of California and three in the Dutch East Indies.

(Secretary's abstract.)

The classification of the hot areas in the Yellowstone Park and the causes of their development. E. T. ALLEN, Geophysical Laboratory, Carnegie Institution of Washington.

The numerous hot areas in the Yellowstone Park, though quite varied in external characteristics, may all be referred to a few distinct types. These are distinguished from one another by the nature of the deposits, the composition of the waters, the abundance of the water-supply, the thermal intensity, etc. The key to the differences in the waters and the deposits is found in the ratio of the sulphur and the water-supplies to one another. The two principal types show a rather striking segregation into distinct areas. This segregation, as well as the wide variations in thermal activity, in the depth of springs, and, in some measure also, in the size of the areas and the abundance of the water supplies, is tentatively attributed to differences in the character of the faulting in different parts of the Park.

(Abstract.)

The acid gases contributed to the sea during volcanic activity. E. G. ZIES, Geophysical Laboratory, Carnegie Institution of Washington.

A study of the emanations given off in the fumarolic area of the Valley of Ten Thousand Smokes brought out the fact that even though the percentage concentration of hydrochloric and hydrofluoric acids in the steam may have been small, yet the aggregate amount emitted per year was very great.

In this paper attention is directed to the importance of considering both the intensity and capacity factor involved in gaseous emanations. These factors govern the kind of work done by the gases. Thus the amount of halides of the various bases that can be transported from a deep-seated igneous body to the surface at some given temperature will depend on the partial pressure or percentage composition of the

acid gas. This is the intensity factor in the steam. On the other hand, for a given temperature, it is the total quantity of these acid gases in the steam that is effective in the alteration of the rocks over which they may be passing. This is the capacity factor.

A specific case of the effect of the capacity factor is discussed, namely: The amounts of hydrochloric and hydrofluoric acids that were contributed per year to the sea. The quantitative basis for these calculations is presented and the theory put forward by Suess and Becker that part of the chlorine of the sea is derived from the hydrochloric acid given off during volcanic activity is discussed.

It is also shown that the amount of hydrofluoric acid emitted by the fumaroles in the Valley of Ten Thousand Smokes is less than the amount of hydrochloric acid but that it is of a similar order of magnitude. The amount of the former acid that was contributed to the sea was so large that some mechanism must be invoked by which fluorine is continuously removed from the sea either through biological or chemical processes or both.

The various methods by which fluorides can be coprecipitated with other substances even when only very small concentrations of fluorine are present in solution are discussed. The great sedimentary phosphate beds of the world are cited as an example of the concentration of relatively large amounts of fluorine through biological and chemical processes. The fluorine content of these beds is discussed both as to percentage concentration and total amount present.

Finally, attention is directed to the desirability first of finding a direct method for the quantitative estimation of small amounts of fluorine; secondly, of making a careful determination of the average and regional fluorine concentration in the sea; and thirdly, of making systematic determinations of the chlorine, fluorine, and boron content of sedimentary and of altered rocks.

(*Abstract.*)

Volcano research of the United States Geological Survey. T. A. JAGGAR, U. S. Geological Survey.

In Hawaii, the tilt, tremor and sulphur accumulation about Halemaumau during 1926 indicated upward magmatic pressure. On July 7, 1927, lava burst through the talus of the bottom of the pit. It followed a line parallel to the Kau Desert cracks. The frothy black basalt spouted at three vents for two weeks, made a new floor about fifty feet thick, threw up small cones all within the pit, and ejected flames and incandescent streams, basaltic pumice and Pele's hair.

There was no unusual earthquake frequency such as accompanies subsidences at Halemaumau. There was no reaction of subsidence nor any inward tilt following the cessation of visible flowing. On January 11, 1928, there was avalanching from Halemaumau walls. One large slide so overweighted the floor of the previous July that pasty incandescent lava flowed up cracks. There was no gas-activity and no eruption followed. The flowing endured only a few hours.

The section of Volcanology of the U. S. Geological Survey is now operating seismographs at Lassen Volcano, Kodiak, Kilauea, Kealakekua and Hilo. Two stations on opposite sides of Kilauea crater, northeast and west, are now registering earthquakes. The new west station is the Uwekahuna observatory on the highest Kilauea summit. The seismograph is a three-component Imamur instrument built by Akashi of Tokyo, with modifications suggested by Jaggar. All three components write on one drum, the damping is magnetic, the suspensions are of wire, and timing devices are being developed by R. M. Wilson whereby the clock-contacts at intervals register the clock-error by wireless on an amplifier-controlled chronograph at the main station. The time at the main observatory is similarly controlled by wireless reception from Pearl Harbor, Mare Island and Arlington.

A new seismograph has been designed and constructed in the shop of the Hawaiian Volcano Research Association by the officers of the Observatory. Three two-component machines are finished and placed for testing, one at Kodiak, Alaska, one in a new specially constructed cellar at Hilo, Hawaii, and one at Cheltenham, Maryland, destined for Sitka, Alaska. These machines hang directly from iron plates in cellar walls, on cardan hinges, with adjustments for period and centering, with hollow heavy masses to be filled with sand at the installation locality, oil damping, jewelled pens, magnification 130 and mass about 80 lbs. The chronograph registers both components on one sheet of smoked paper, and the time-marks are gaps in the record made by a Howard clock through lift of the pen-tips electro-magnetically. Time is received by wireless and the correction impressed on the seismogram once a day through a telegraph key.

During the past year, geodetic coöperation by the Coast Survey has created a new line of precise levelling to the top of Mauna Loa, a new tide-gauge station at Hilo and gravity measurements at Hilo, Kilauea and Mauna Loa. The levelling will be repeated from time to time to check changes of elevation. The tide-station will be con-

tinued, and the mareograms are recorded by Mr. Wilson with a view to discovering tidal waves and interpreting changes of elevation of the Hilo bench-mark datum. The gravity measurements indicated anomalies in the direction of excess of mass, Kilauea greater than Hilo, and Mauna Loa greater than Kilauea.

The Uwekahuna observatory at Kilauea is also a museum and lecture hall, and this has been transferred to the National Park Service for motion-picture lectures to tourists and explanations of the geology of the crater by ranger-naturalists. Retriangulation of the Kilauea net and adjustment of the observations by Mr. Wilson has disclosed constriction of the crater, to match the vertical collapse that accompanied the explosive engulfment of 1924.

The Lassen volcano observatory has now been in service for a year and a half under R. H. Finch. No eruptions of Lassen Volcano have occurred. Occasional local seismic spells are indicated by the seismograph at Mineral. Hot-spring temperatures have been measured here and in the steam region of Sonoma and Napa Counties.

Dr. Jaggar established a seismograph in the basement of the residence building of the Agricultural Experiment Station at Kodiak, Alaska, in August 1927. At the end of August there was an explosive eruption of Mageik volcano in the Katmai group in the Alaskan peninsula. This caused falls of pumice and ash in the western bays of Kodiak Island for several days. In the first week of July he visited Gareloi and Bogoslof volcanoes in the Aleutian Islands. Gareloi was sending up dense yellow fumes from its summit crater-cup. Bogoslof was in full lava eruption after the fashion of 1907. A pile of steaming andesite had risen between Castle Rock and Grewingk, surrounded by a warm salt-water lagoon at 74°F. The outer sea water was at 50°. The lagoon was nearly circular, and surrounded by a gravel ridge, without any channel connecting lagoon and ocean. On the gravel were impact craters and clinkery black bombs and pumice boulders. There were hundreds of sea lions, and thousands of murres and gulls. The new activity of Bogoslof had started in mid-July, 1926, as reported by mariners, and prior to that there had been open sea water between Grewingk and Castle Rock. There were explosions every few months in 1926 and 1927. Akutan volcano was wholly quiet in the summer of 1927, Shishaldin and Mount Martin were steaming.

The 1927 reconnaissance of the Aleutian belt had in view the establishment of a seismograph station at Dutch Harbor as well as at Kodiak, and as both of these places are Naval radio stations, good

time service is assured. The Dutch Harbor instrument will be installed in 1928. The reconnaissance included a journey to Bristol Bay, another to Attu and exploration in a motor-boat of Pavlof Bay, Volcano Bay, Belkoski and Morzhovoi Bays, and examination of the Izembek shore of Bering sea. These explorations revealed an unnamed volcano approximately 5000 feet high southwest of Pavlof Peak, to which the name Dutton Peak was tentatively given. It was also determined that the Aghileen Pinnacles are very remarkable minaret peaks apparently encircling a basin. The exploration of the whole group will be continued, a topographic map will be made, and photographs, both cinematographic and still, will be taken in the summer of 1928, by an expedition of the National Geographic Society, directed by Mr. Jaggar.

Active exploration of the Aleutian belt for natural history purposes depends on maps. The making of hydrographic charts and topographic maps may be done most expeditiously by joint service of the Coast Survey and the Geological Survey from Dutch Harbor. The buildings there are available as a base. There is needed a sea-worthy Diesel yacht of the halibut-boat class for this purpose; the boat should be of shallow draft and from 60 to 100 feet long. Both government services are ready to begin work in 1929. If appropriations for such a vessel can be obtained, with a small increase of funds, the Volcano Section of the Geological Survey will place an associate volcanologist in Alaska permanently.

ENTOMOLOGY.—*A new* Reticulitermes *from Baltic Sea amber (Insecta—Isoptera).*[1] THOMAS E. SNYDER, Senior Entomologist, Bureau of Entomology, U. S. Department of Agriculture.

Among a collection of fossil termites, which I purchased several years ago, is a very small new species of *Reticulitermes*, Family Rhinotermitidae. The other fossil termites in this collection are representatives of the Families Kalotermitidae and Rhinotermitidae; no species in the highest family, Termitidae, have been found in Baltic amber.

This new *Reticulitermes* shows that several distinct species in this genus existed in the warmer Baltic region of the Lower Oligocene period, several millions of years ago, and that the very destructive species now living in the Palaearctic and Nearctic regions of the world are remnants of an ancient genus, once more widely distributed, including in prehistoric times diverse forms not greatly different from living species.

[1] Received September 27, 1928.

Reticulitermes minimus Snyder, n. sp. (Figure 1)

Winged adult.—Head dark castaneous brown, longer than broad, with scattered long hairs; ocelli separated from compound eyes by a distance slightly less than the long diameter of an ocellus. Postclypeus lighter colored than head, dark yellow-brown, bilobed.

Antennae dark yellow-brown, with 14 segments; with long hairs on segments.

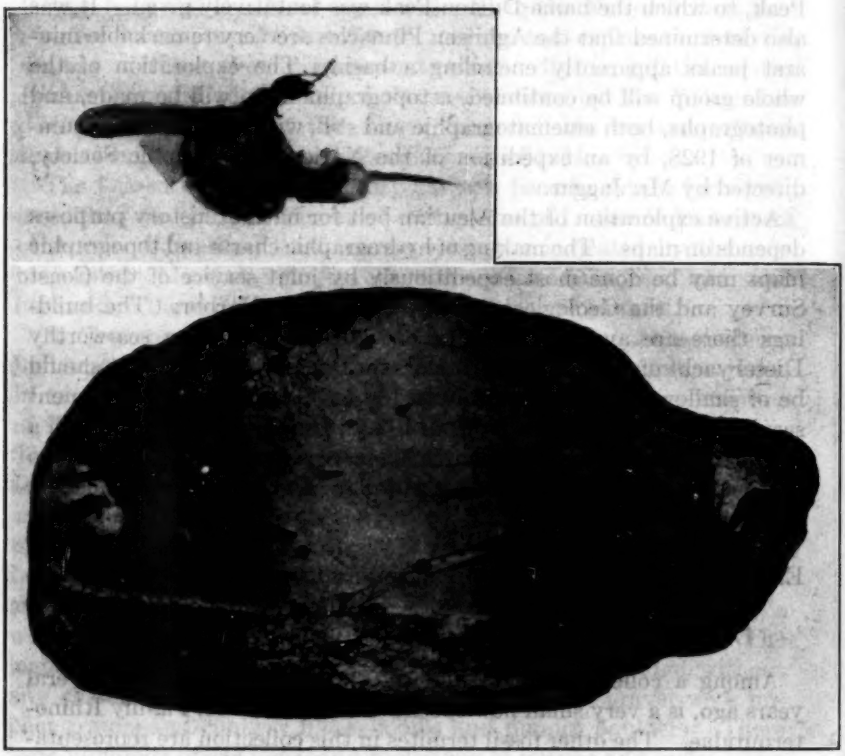

Figure 1a (below).—The winged adult of *Reticulitermes minimus* in Baltic Sea amber. Dorsal view, × 2½.

Figure 1b (above).—View showing details of wing venation, × 6.

Pronotum slightly lighter in color and not as broad as the head, roundedly and shallowly emarginate posteriorly; long hairs on margins.

Wings of a smoky color, costal area darker, membrane markedly reticulate, but no hairs on margins of wings, except at base, on wing scale or stub.

Legs with tibiae not darkened.

Measurements:—

Length of entire winged adult: 6.15 mm.

Length of head: 0.90 mm.
Length of pronotum: 0.35 mm.
Length of fore wing (to wing scale or base): 4.40 mm.
Length of fore wing scale: 0.50 mm.
Long diameter of eye: 0.22 mm.
Width of head (at the eyes): 0.60 mm.
Width of pronotum: 0.50 mm.
Width of fore wing: 1.20 mm.

Holotype, winged adult, number 41546, U. S. National Museum.

PROCEEDINGS OF THE ACADEMY AND AFFILIATED SOCIETIES

BIOLOGICAL SOCIETY

714TH MEETING

The 714th meeting was held at the Cosmos Club, January 14, 1928, with President GOLDMAN in the chair and 205 persons present. New member elected: ROBERT SHOSTECK.

E. A. GOLDMAN was nominated as Vice-president of the WASHINGTON ACADEMY OF SCIENCES to represent the Biological Society.

R. M. LIBBEY mentioned the observation of a saw-whet owl in Arlington Cemetery on a recent walk of the Audubon Society.

A. N. PACK, American Nature Association: *In Glacier Park with the white goats, big horns, beavers, and other wild life* (illustrated).—The speaker showed several reels of moving pictures taken on a recent trip to Glacier Park by himself, W. L. FINLEY, and others, and gave an account of the trip. The pictures of mountain goats were especially noteworthy.

VERNON BAILEY: *A real live beaver from Michigan.*—The speaker exhibited a beaver about nine months old and weighing about twenty pounds belonging to VICTOR J. EVANS. For about twenty minutes the animal sat quietly on a small table in front of the audience and munched a large sweet potato and a few crusty rolls. The beaver is kept in a special house and presents an unusual opportunity for studying its food preferences and general habits. Captured beavers very quickly become tame and are extremely gentle and intelligent pets. A large old beaver weighing 50 pounds is just as quiet and gentle when first taken from the live trap as was this young one. Further studies are being carried on, and later it is hoped that something can be learned of their breeding habits and other habits which are important in the management of the many beaver farms being started in the north country.

S. F. BLAKE, *Recording Secretary.*

715TH MEETING

The 715th meeting was held at the Cosmos Club, January 28, 1928, with President GOLDMAN in the chair and 58 persons present. New member elected: Mrs. MARGARET M. NICE.

E. P. WALKER presented notes regarding the weight of elk.

THOMAS K. CHAMBERLAIN, U. S. Bureau of Fisheries: *Life history and conservation of fresh water mussels of the Mississippi River* (illustrated).—The speaker outlined research work in progress and the importance of mussels commercially in button manufacture and pearl production, 40,000 to 50,000

tons of shells being used annually in button manufacture, having an aggregate value of from $7,000,000 to $8,000,000. The life history of mussels, including development of the eggs in the *marsupium* of the mussel gill chamber, the manner of attachment of the *glochidia* to fish, their growth, development, and distribution were discussed. Recent experiments employing a culture medium designed to eliminate the heavy losses of mussel glochidia under natural means of development and distribution were described and the importance of making the production of mussels a farming proposition through planting of suitable mussel-producing areas was stressed.

LEWIS RADCLIFFE: *The International Halibut Commission.*—The history and work of the Commission, the importance of the halibut fisheries, and the life history and habits of these fish. The system of tagging fish as a means of studying their migration on the various important banks and the significance of the percentage recaptured as a means of determining the percentage of all fish taken in the commercial fisheries was discussed. He also called attention to the strenuous and often dangerous character of the work of the crews and scientific staff engaged in the work.

W. H. RICH discussed the two preceding papers briefly and called attention to the importance of research work now being conducted upon the salmon of the Pacific Coast which he stated would be discussed in greater detail by Commissioner O'MALLEY. Brief comments were also made by President GOLDMAN on observations made in connection with the menhadden fisheries.

W. B. BELL, *Recording Secretary pro tem.*

716TH MEETING

The 716th meeting was held at the Cosmos Club, February 11, 1928, with President GOLDMAN in the chair and 135 persons present. New member elected: BOWEN S. CRANDALL.

A resolution regarding the recent death of BRADSHAW H. SWALES was presented.

F. L. THONE announced that the translation of WILLSTAETTER's great work on chlorophyll by Dr. F. M. SCHERTZ has just been published.

C. W. STILES reported the receipt from the central West of an interesting specimen, consisting of the cyst of the larval stage of an armed tapeworm. Twelve such cysts were found in the brain of a foreigner, who was taken with Jacksonian epilepsy and died in a few hours. It was probably a case of reversed parasitization. The disease is very rare in the United States.

EDGAR BROWN reported that for the last three winters a female cardinal had been in the habit of flying repeatedly against a window in his house. The window has been covered with a screen to prevent injury to the bird, but it still flies against it. Dr. WETMORE stated that this habit is well known, and that it is generally believed that it is an attempt on the part of the bird to fight its own reflection.

HENRY O'MALLEY: *Life and habits of the fur seal and the salmon of the Pacific coast* (illustrated).—The speaker showed several reels of moving pictures from the Alaskan coast and islands, in part taken by the Finley-Church Expedition, showing nesting murres, sea lions, blue foxes, fur seals, and the pursuit, capture, and subsequent disposal of a whale. The different methods of capturing salmon were also fully illustrated. In conclusion, a film was shown, taken at the Fish Commission Building, showing the way in which the male large-mouth black bass guards its young from other predaceous fish. Discussed by LEWIS RADCLIFFE, who mentioned that 75 per cent of the world-

take of sealskins comes from the Pribilof Islands and 60 per cent of the world-pack of canned salmon from Alaska.

717TH MEETING

The 717th meeting was held at the Cosmos Club, February 25, 1928, with President GOLDMAN in the chair and 110 persons present.

L. O. HOWARD gave an account of the last meeting of the New Jersey Mosquito Extermination Association. Discussed by C. H. MERRIAM.

A. A. DOOLITTLE, referring to the cardinal reported at a previous meeting as persistently flying against a window to fight its reflection, suggested that it would be interesting to hang a white curtain behind the window to cut off the reflection.

C. D. MARSH reported the fatal poisoning of a ranger in Yellowstone Park last year from eating the roots of a species of *Cicuta*, mistaken for edible camas.

W. B. MILLER: *Alaska reindeer and forage problems* (illustrated).—The speaker showed numerous slides of Alaskan scenery and animals and discussed the reindeer situation in Alaska, referring particularly to numbers of animals, range problems, and the results of cross-breeding experiments with reindeer and caribou.

C. W. STILES: *Zoology and religion*.—The speaker presented by request a paper already given before the Mt. Pleasant Congregational Church, an abstract of which has appeared in Science 47 (no. 1729): Suppl. p. xiv. Discussed by C. H. MERRIAM, who defined religion as the relation of man to the supernatural, and illustrated by reference to the religions of the California Indians.

718TH MEETING

The 718th meeting was held at the Cosmos Club, March 10, 1928, with President GOLDMAN in the chair and 95 persons present. New member elected: L. T. GAGER.

TITUS ULKE exhibited a specimen of pelicanflower, *Aristolochia grandiflora sturtevantii*, and discussed its fertilization.

A. S. HITCHCOCK stated that funds are now being raised to finance the work of the Interim Committee on Botanical Nomenclature appointed at the International Botanical Congress at Ithaca in 1926. Discussed by C. W. STILES, who felt that the work of such a committee should be supported by one of the big scientific foundations. Nomenclature is not a mere academic matter, and a great amount of time and money is lost through changes in names which bring no corresponding return to science.

STANLEY P. YOUNG: *Predatory animals and methods for their control* (illustrated).—The speaker described the four main predatory animals in the far West, the wolf, mountain lion, coyote, and bobcat, as well as the stock-killing bear. The early history of organized procedure against predatory animals as practiced by the Biological Survey was briefly discussed. This brought in brief mention of the rabies epidemic among coyotes occurring on the far western ranges, particularly in the States of Nevada, Utah, Idaho, and Oregon, at the same time stressing the fact that the coyote is a harborer of rabies. The history of the coöperative development of predatory animal control work was also discussed as this coöperation pertains to the various range States, counties, and local stock and game associations. The various methods used by the Biological Survey in controlling predatory animals were described, three main methods of control in particular, trapping, poisoning,

and den hunting, being graphically illustrated by lantern slides. Depredations occasioned by predatory animals to stock and wild game were also stressed and examples of such depredations shown on the screen. In describing the wolf infestations which occurred in Colorado in 1921, a brief account was given pertaining to each individual wolf pack known to exist in that State, which totalled 8 individual packs, the largest of which contained 33 wolves. In the 8 packs were 9 distinct outlaw wolves which taxed the ingenuity of the Government hunters to the utmost before they were captured. (*Author's abstract.*)

ERNEST P. WALKER: *Alaska bird colonies* (illustrated).—Bird colonies are ordinarily supposed to be few and far between, and in most regions they are, but again Alaska proves the exception. In addition to the notable colonies of sea birds on Forrester, Hazy, St. Lazaria, Tuxedni, Bogoslof, St. Matthew, Chamisso, and the Aleutian Chain, administered by the Biological Survey, and the Pribilof Islands, administered by the Bureau of Fisheries, there are numerous less well-known islands and portions of the mainland coast where large numbers of sea birds nest. The ledges and cliffs of both islands and mainland coast supply nesting sites for more than twenty-five species of birds. The swampy delta regions and tundra country, so extensive in some sections, afford choice homes for myriads of ducks, geese, brant, swans, and shorebirds of a number of species. The sand and gravel bars and glacial moraines as well as the swampy sections afford nesting sites for the Aleutian and arctic terns, gulls, and shorebirds. (*Author's abstract.*)

719TH MEETING

The 719th meeting was held at the Cosmos Club, March 24, 1928, with President GOLDMAN in the chair and 135 persons present.

C. W. STILES exhibited a bottle containing 365 specimens of *Ascaris lumbricoides*, all taken from a child about three years old, and commented on the symptoms shown by such a serious infestation. Cases sometimes terminate fatally although this one did not.

F. G. ASHBROOK: *Muskrat farming* (illustrated).—The muskrat is now the most important fur animal, commercially, in the United States, the average annual production of skins being about 13 million. Its ability to maintain itself in the face of constantly changing conditions makes it of great economic importance, and a large amount of acreage is now devoted to the raising of muskrats, particularly marsh areas bordering the Great Lakes and tidewater marshes of New Jersey, Delaware, Maryland, and Louisiana. The first essential is good marshland, with luxuriant food and sufficient water so that it will not freeze solid during the winter. The entire area should be inclosed in a fence to retain the muskrats and keep out enemies. Marsh areas on the eastern shore of Maryland have yielded as high as 4205 pelts in a season from 800 acres, while in Louisiana 163,000 acres of marshland produced 350,000 muskrats. Muskrat raising is particularly profitable because the carcasses as well as the pelts are salable. In 1904 muskrat pelts were selling at about 25 cents each and the carcasses at about $1 a dozen. In 1925 the pelts were $1.50 each and the carcasses $3 a dozen. The carcasses are packed in ordinary barrels and sold on the markets of Baltimore, Washington, Wilmington, and Philadelphia under the name of "marsh rabbit," but in using this name no attempt is made to conceal the fact that the offering is muskrat meat. The flesh, a light mahogany color just after the pelt is removed, becomes darker when exposed to the air. It is almost black after it is fried and therefore not very appetizing, but is greatly appreciated by some

people. The breeding season starts late in February or early in March in the northern part of North America, and earlier in the South. The average litter produced by a young female is about four, but animals two years old average eight to ten young to the litter. Young born in the first litter in the spring will produce young in the fall. Pen-raised muskrats produce three litters a year; but four and sometimes five litters have been born when autumn weather was mild. The young muskrats are blind and naked when born, but develop rapidly. Muskrat farmers have shown that the muskrat is polygamous.

N. B. McCLINTOCK: *The ways of beaver* (illustrated).—The speaker, a member of the faculty of the University of Pittsburgh who devotes his time to making moving pictures of wild life to be used for educational purposes, exhibited excellent moving pictures of beaver taken in Pennsylvania and Michigan. The animals are monogamous and mate for life. The houses are of two types, bank houses and island houses. The houses are usually about six feet in diameter inside and may be twelve feet across outside, and usually have two or more entrance holes. The floor is lifted only four to six inches above the level of the water, in order that the weight of the stick the beaver is eating may be supported principally by the water. The animals do not hibernate, but feed every day during the winter on the supply of branches gathered during the fall. They swim by alternate strokes of the hind feet at a rate of about five miles an hour when not frightened. The speaker found that the beaver could remain under water for at least nine and a half minutes. They have from three to six young, born in April. The pictures exhibited showed a mother beaver with six young beavers, beavers repairing a broken dam, and other aspects of their life. Discussed by C. W. STILES and P. B. JOHNSON, with especial reference to possible correlation between their ability to remain so long under water and the size of the liver and suprarenal glands.

S. F. BLAKE, *Recording Secretary.*

THE GEOLOGICAL SOCIETY

441ST MEETING

The 441st meeting was held at the Cosmos Club, April 25, 1928, President HEWETT presiding.

Informal communications: W. C. MANSFIELD called attention to an exposure in a stone quarry about 8 miles south of Emporia, Va., where three formations and two unconformities are exposed. The lower 50 feet of the outcrop consists of the basement rocks. Fossiliferous strata 7 or 8 feet thick occupy a depression in these basement rocks. The fossils indicate that the formation is marine Yorktown (Miocene), here much farther inland than previously reported. The Yorktown formation is in turn overlain by unfossiliferous terrace deposits. Discussed by R. S. BASSLER.

WALDEMAR LINDGREN reported the discovery of the bismuth mineral, wittichenite ($3Cu_2S \cdot Bi_2S_3$), in a mine 6 miles from Cerro de Pasco, Peru. This is the first known occurrence of this mineral in North or South America.

Program: Prof. W. H. BUCHER, University of Cincinnati: *Cryptovolcanic regions.* The term "crypto-volcanic" was coined by Branca and Fraas[1] for the structure of the Steinheim Basin in Southern Germany. The basin forms

[1] W. BRANCA and E. FRAAS. *Das kryptovulkanische Becken von Steinheim.* Abh. Kön. Preuss. Akad. Wiss. 1905.

a ring-shaped depression of 1½ miles diameter in the limestone plateau of the Schwaebische Alp. Its center is occupied by a hill crowned with deposits of calcareous sinter. Natural exposures and tunnels dug for the purpose of geological investigation have proved this central hill to consist of older rocks carried above their normal level in intensely disturbed position. The basin surrounding it is the result of a depression below the normal level. Originally, in Miocene time, the basin was occupied by a freshwater lake in which deposits were laid down that have become famous for their mammal and fish remains.

The essentially circular outline, an outer ring-shaped depression and a central uplift, unaccompanied by true volcanic activity, are the characteristics of the American crypto-volcanic structures as well. Two such structures have been mapped by the writer since 1920: The "Serpent Mount Structure," on the boundary line of Adams and Highland Counties in Ohio,[2] and the "Jeptha Knob Structure," centering in the isolated Jeptha Knob of Shelby County, Kentucky.[3] A third structure of apparently similar nature, Wells Creek Basin, of Stewart County, Tennessee,[4] will be mapped by the writer this summer for the Tennessee Geological Survey.

Two major objections have been raised against the interpretation of these structures as of volcanic origin:

1.—The interior of the United States has since Cambrian time been notoriously free from all volcanic activity. It seems unjustified in such a region to turn to vulcanism for the explanation of structures not associated with lavas or tuffs, or at least with some evidence of contact metamorphic alterations.

2.—Even if a volcanic origin were conceded, no known volcanic process seems adequate to account for the peculiar character of the disturbance. The structures are decidedly not of laccolithic character. Up to the very edge of the structures the surrounding stata lie undisturbed. The magmatic body whose activity is reflected at the surface must therefore have had the shape of a plug. But no process is known that would allow us to picture the rise of a volcanic plug, 1½ to 4 miles in diameter near the surface, without making room for the ascending lava column by volcanic explosion.

As to the first objection, it can be shown that while true vulcanism is absent in the interior of the United States, the number of places is growing constantly in this region where igneous rock is found to have risen to the now exposed level of the stratosphere. In all such cases the amount of contact metamorphism is negligible. A few especially significant cases referred to in the address follow. In the case of the peridotite dike of Fayette County, Pennsylvania, the contact effects are nil in limestone and extend but a few inches in the shales. This dike is especially instructive in the fact that it does not reach the surface and yet, according to L. B. Smith,[5] at one place it has lifted a zone 12 feet wide in the Waynesburg sandstone, four feet.

In Hardin County, Illinois, the association of the intricate block faulting, and especially the nearly circular, abrupt Hicks dome, with lamprophyre and

[2] W. H. Bucher. *Crypto-volcanic structure in Ohio of the type of the Steinheim Basin (Abstract)*. Bull. Geol. Soc. Am. **32**: 74. 1921. Complete report in preparation for Ohio Geol. Surv.

[3] W. H. Bucher. *Geology of Jeptha Knob*. Ky. Geol. Surv. (6) **21**: 193–237. 1925.

[4] See *Geologic map of Tennessee*. Tenn. Geol. Surv. 1919; also *Erin Quadrangle* topographic sheet, Tenn.

[5] L. B. Smith. *Biennial Rept.* 1910–12. Pa. Top. Geol. Surv. **1912**: 150–156.

peridotite dikes and with tuff-like materials as in the Sparks Hill plug, is significant.[6] In Missouri, on the Camden-Laclede County line, in the midst of an area of abnormal and rapidly changing dips, a pegmatite dike outcrops, covering but a few square yards. "The rocks for many acres around, representing the lower formations, either stand on edge or are greatly tilted."[7] Metamorphic effects are limited to the immediate contact. On the Rose Dome, in Woodson County, Kansas, intrusive granite outcrops over something like 100 acres. Metamorphism is limited to a distance of 15 inches from the outcrop.[8]

In Riley County, Kansas, a porphyritic peridotite forms an outcrop of about one acre. This small size makes it improbable that this, like the other igneous bodies quoted above, ever reached the surface. In this case the abundance of shale inclusions is significant. They amount to $\frac{1}{3}$ to $\frac{1}{4}$ of the volume of rock.

These, together with the scattered discoveries of less significant volcanic dikes, show that volcanic materials actually traveled upward into the stratosphere in the interior of the United States, and that it is characteristic of them not to have reached the original surface.

The second objection is removed by observations of Du Toit in South Africa. He has described volcanic plugs that never reached the surface. He called them "bell-jar shaped intrusions." The observations were made in much dissected country of up to 1500 feet relief, with many excellent natural sections where the details were quite clear, justifying this description:

"The magma welled up along a fracture that was oval in plan and thus came to isolate a vertical and presumably cylindrical mass of sediments from the surrounding horizontal strata. It then spread out at the top, thus severing the enclosed column from the formation above; the nature of the base is purely conjectural. Deprived of support on all sides, the contents of the 'bell-jar' collapsed, the strata within became extensively injected with the magma, suffered tilting—sometimes to a high angle—and as a whole experienced considerable subsidence as well."[9] It is characteristic that almost up to the edge of the structure, the surrounding rocks lie undisturbed. Here, then, we have definite evidence that circular plugs of volcanic material have risen into the stratified rocks nearer the surface without breaking through.

It is interesting to note that the diameters of these South African bell-jar intrusions compare well with those of the known crypto-volcanic structures. The smallest has the same diameter as the Steinheim Basin, $1\frac{1}{2}$ miles. The two larger ones, $3\frac{1}{2} \times 6$ miles and 4×7 miles, compare favorably with the largest American example, the Serpent Mound Structure with a diameter of about 4 miles.

The conclusion seems justified, therefore, that crypto-volcanic structures represent surficial disturbances produced by circular or elliptical plugs that rise as "bell-jar injections" and fail to reach the surface. As such they are to be expected in regions which are free from volcanic activity and show

[6] L. W. CURRIER in STUART WELLER. *The geology of Hardin County.* Ill. Geol. Surv. **41**: 237–244. 1920.

[7] E. M. SHEPARD, letter quoted in C. N. GOULD. *Crystalline rocks of the Plains.* Bull. Geol. Soc. Am. **32**: 548. 1923; ARTHUR WINSLOW. *Lead and zinc deposits. Pt. 2.* Mo. Geol. Surv. **7**: 432–433. 1894.

[8] W. H. TWENHOFEL. Bull. Geol. Soc. Am. **37**: 403–412. 1926.

[9] A. L. DU TOIT. *The Karoo dolerites of South Africa; a study in hypabyssal injection.* Trans. Geol. Soc. South Africa **23**: 10–11. 1920 (1921).

igneous rocks only in the form of scattered dikes and finger-like plugs that at the time of intrusion failed to reach the surface, and have been made visible only by regional denudation.

Discussed by Messrs. KEITH, GILLULY, HEWETT, STOSE, BAKER, BASSLER, and SEARS.

ARTHUR KEITH: *Structure composite of North America.* (See Bull. Geol. Soc. Am. **39**: 321–385. 1928.)

Discussed by Messrs. G. R. MANSFIELD, BUCHER, REESIDE, and SCHUCHERT.

442D MEETING

The 442d meeting was held at the Cosmos Club, May 9, 1928, President HEWETT presiding.

Informal communication: W. C. ALDEN showed several photographs of the Sperry Glacier, Glacier National Park, Mont., taken in August, 1913, and 14 years later, in August, 1927. This small glacier, in the west side of the Continental Divide near Lake MacDonald, lies in a north-facing cirque above the great cliff at the head of Avalanche Basin. The foot of the glacier is 7,000–7,400 above sea level.

In 1913 the front of the glacier rested on top of the innermost ridge of the latest terminal moraine. This rock moraine is very fresh, with no soil nor vegetation upon it. By 1927 the front of the glacier had receded about 100 yards from the 1913 moraine, leaving exposed a bare rock surface with scattered pebbles and boulders upon it. A short distance outside the 1913 moraine is an older moraine somewhat smoothed down by erosion and with scrubby trees growing upon it. These relations are in accord with the opinion among geologists that the fronts of glaciers in the United States are, in general, receding.

Program: C. W. COOKE: *The stratigraphy and age of the Pleistocene deposits in Florida from which human bones have been reported.* (This JOURNAL **18**: 414–421. 1928.)

J. W. GIDLEY: *The contemporaneity of man and extinct animals in Florida.*

O. P. HAY: *Age of the "No. 2" bed at Vero and Melbourne.*

Joint discussion of the three papers by Messrs. W. C. ALDEN, PAUL BARTSCH, A. V. KIDDER, J. B. REESIDE, JR., H. G. FERGUSON, and W. T. SWINGLE.

W. W. RUBEY, A. A. BAKER, *Secretaries.*

SCIENTIFIC NOTES AND NEWS

N. ERNEST DORSEY, Associate Editor of the International Critical Tables of Numerical Data, has been appointed Principal Consulting Scientist (Physics) in the Bureau of Standards.

EDGAR W. WOOLARD, assistant meteorologist, U. S. Weather Bureau, has resigned to accept an appointment as instructor in the Department of Mathematics at George Washington University for the academic year 1928–29.